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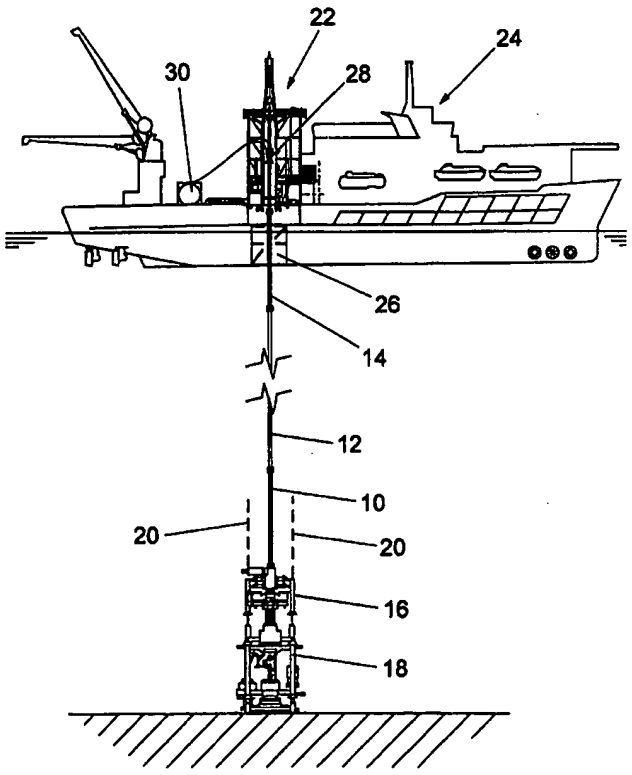
(54) Title: MARINE RISER AND METHOD OF USE

(57) Abstract

A marine riser, particularly but not exclusively for use in connecting a subsea well installation to a dynamically positioned servicing vessel, comprises at least one section formed from rigid pipe and at least one section formed from flexible pipe. Preferably, the upper and lower sections (10, 12) are formed from fixed lengths of flexible pipe and the central section is formed from a plurality of lengths of rigid pipe which may be assembled to make up any required length. The riser may be deployed from a moonpool of the vessel and serves to accommodate movements of the vessel on the surface. This allows the use of a dynamically positioned service vessel rather than a conventional drilling rig.



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"Marine Riser and Method of Use"

The present invention relates to a marine riser and to methods of using such a riser. The marine riser is useful for a variety of possible applications in the offshore oil and gas industry, but is particularly intended for use in the drilling, servicing ("well intervention") and abandonment of subsea well installations.

There is a need for a variety of maintenance and service operations to be carried out on subsea wellheads, following completion of the well and throughout the operational lifetime of the well. Many of such operations require a conduit ("riser") to connect the wellhead to the surface of the water, allowing coiled tubing or the like to be introduced into the bore of the well, through the riser. Conventionally, such operations have usually been performed using a riser formed from rigid steel drill pipe deployed from a conventional drilling rig (typically a mobile semi-submersible type rig). This has numerous disadvantages. Such rigs are expensive, slow in transit between tasks at different locations and cumbersome in use.

It would be desirable to carry out such operations using a conventional, dynamically-positioned drilling vessel, equipped with a standard oilfield derrick. Difficulties arise when using such a vessel with a

conventional rigid riser, primarily because a vessel of this type is substantially less stable than a semi-submersible rig. In order to use such a vessel for the deployment of marine risers it is necessary to control bending moments arising from environmental loads on the riser and from roll, pitch, sway and yaw of the vessel.

This problem has been addressed in the past in a variety of ways, including:

(a) Rigid risers manufactured from high performance materials and/or with complex geometries which can absorb the bending forces. This approach is expensive in terms of materials and manufacturing costs.

(b) Application of extremely high tensions to the riser. This creates a whole range of other problems.

(c) Forming the riser wholly from flexible pipe. Such pipe is expensive, and the length of the riser must match the water depth quite closely, so that a range of different lengths will be required for different operations. A storage carousel for the flexible pipe is also required on the vessel, where deck space is limited.

(d) The use of "flex-joints", such as those marketed by Oil States Industries of Arlington, Texas, USA. A joint of this type comprises a short articulated conduit with a flexible coupling connecting two rigid conduit sections, one of which includes a massive collar enclosing an elastomeric bearing. Devices of this type are bulky, massive and extremely expensive, and accommodate only a limited range of riser deflections (typically +/- 10°).

It is an object of the invention to provide a marine riser which can be deployed from a conventional oilfield rig on a conventional dynamically-positioned drilling vessel and which obviates or mitigates the

various problems outlined above. The riser may also be useful in other fields of application within the offshore engineering industry.

In accordance with a first aspect of the invention, there is provided a marine riser in which at least part of the length of the riser is formed from at least one length of rigid tubular pipe and at least part is formed from at least one length of flexible pipe.

In its preferred embodiment, the riser comprises a central rigid section and uppermost and lowermost flexible sections.

The at least one rigid section preferably comprises a plurality of rigid pipe joints assembled together to make up the length required and the at least one flexible section is pre-fabricated to a predetermined length.

The at least one flexible section may be provided with bend restricting devices adapted to resist bending and/or bend limiting devices adapted to limit the minimum radius to which the flexible pipe may be bent.

The various flexible and rigid sections may be connected to one another by any suitable means, including flange, hub and screw-threaded connectors. The ends of the riser are adapted for connection to subsea installations and to apparatus on board the vessel, respectively, as required for a particular operation. The lowermost end may have a package of apparatus connected thereto for connection to the subsea installation.

In accordance with a second aspect of the invention

there is provided a method of deploying a marine riser between a vessel and a subsea installation, comprising lowering a riser from the vessel to the subsea installation and connecting the lower end of the riser to the subsea installation, wherein the riser includes at least one length of rigid tubular pipe and at least one length of flexible pipe.

Preferably, said at least one length of rigid tubular pipe comprises a plurality of pipe joints which are connected together as the riser is lowered from the vessel.

Preferably also, the method comprises lowering a first length of flexible pipe, connecting a first rigid pipe joint to an upper end of said flexible pipe, lowering said rigid pipe joint, connecting additional rigid pipe joints to the upper end of the preceding pipe joint and lowering said additional pipe joints, as required, connecting a second length of flexible pipe to the upper end of the last rigid pipe joint and lowering said second length of flexible pipe.

Preferably also, the vessel is a dynamically positioned vessel and the pipe is lowered from a derrick located on the vessel, via a moon-pool.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawing which shows a side view of a marine riser in accordance with the invention being deployed from a dynamically positioned vessel.

Referring now to the drawing, a marine riser embodying the first aspect of the invention comprises a lowermost length of flexible pipe 10, an intermediate length of

rigid pipe 12 and an upper most length of flexible pipe 14. A lower riser package 16 is connected to the lowermost end of the lowermost flexible pipe 10 for connection to a subsea installation such as a subsea wellhead 18.

The rigid pipe may be of the same type used in conventional rigid risers. The flexible pipe is preferably of the type used for flexible marine risers, as described in detail in API 17B (Recommended Practice) and API 17J (Specifications).

Together, the sections 10, 12 and 14 of the riser make up a length sufficient to reach from the surface to the subsea wellhead 18, plus a degree of slack permitting movements of the vessel to be absorbed by the flexible sections 10 and 14. Optionally, guidelines 20 may also be used to assist deployment of the riser, as is well known in the art.

The riser is deployed using a conventional oilfield derrick 22, or equivalent, mounted on a dynamically positioned vessel 24, via a moon-pool 26. The derrick preferably incorporates motion compensation and/or constant tension apparatus, as is well known in the art.

The invention contemplates risers comprising at least one flexible and at least one rigid portion. The illustrated example is a preferred embodiment. However, it will be appreciated that the same objects could be achieved with different combinations of rigid and flexible sections. In general, it is preferred that at least the uppermost and lowermost sections be flexible.

The riser is deployed from the derrick in a manner similar to conventional drill pipe and risers. The first flexible section 10 would be lowered from the vessel with the package 16 connected to its lowermost end. Joints of drill pipe would then be connected and lowered to make up the required length of the rigid section 12 of the riser, and the final flexible section 14 would then be connected and lowered. The various lengths of flexible and rigid pipe may be connected by any suitable means, including flange, hub or screw-threaded connectors.

The flexible sections 10 and 14 of the riser may be fitted with bending restrictors (stiffeners), vertebrae (bending limiters) and integral or attached buoyancy, as is also well known in the art.

The rigid and flexible pipe employed will be selected according to the requirements of the task to be performed using the riser, so as to provide pressure containment, tensile support and fluid path, for example. The riser may also be configured to act as a conduit for coiled tubing, wireline and electric line activities, well stimulation, gas injection or water injection etc. The vessel will be equipped with appropriate apparatus for the task at hand, such as an injector head 28, coiled tubing reel 30 etc.

The riser is specifically intended for the deployment of lightweight risers for well-servicing and well-abandonment operations carried out from a dynamically positioned vessel using coiled tubing. However, it may also find application in a range of other marine oilfield activities, and could also be deployed from conventional semi-submersible drilling rigs and drilling ships.

The advantages of the invention over conventional alternatives include low cost, simplicity, ease of inspection and testing, compactness (allowing spare components to be carried by the vessel) and ability to be stacked up by conventional derrick equipment.

Improvements and modifications may be incorporated without departing from the scope of the invention.

Claims

1. A marine riser in which at least part of the length of the riser is formed from at least one length of rigid tubular pipe and at least part is formed from at least one length of flexible pipe.

2. A marine riser as claimed in Claim 1, wherein the riser comprises a central rigid section and uppermost and lowermost flexible sections.

3. A marine riser as claimed in Claim 1 or Claim 2, wherein the at least one rigid section comprises a plurality of rigid pipe joints assembled together to make up the length required and the at least one flexible section is pre-fabricated to a predetermined length.

4. A marine riser as claimed in any preceding Claim, wherein the at least one flexible section is provided with bend restricting devices adapted to resist bending and/or bend limiting devices adapted to limit the minimum radius to which the flexible pipe may be bent.

5. A marine riser as claimed in any preceding Claim, wherein the various flexible and rigid sections are connected to one another by any suitable means, including flange, hub and screw-threaded connectors.

6. A marine riser as claimed in any preceding Claim, wherein lower and upper ends of the riser are adapted for connection to subsea installations and to apparatus on board a vessel, respectively.

7. A method of deploying a marine riser between a vessel and a subsea installation, comprising lowering a

riser from the vessel to the subsea installation and connecting the lower end of the riser to the subsea installation, wherein the riser includes at least one length of rigid tubular pipe and at least one length of flexible pipe.

8. A method as claimed in Claim 7, wherein said at least one length of rigid tubular pipe is formed from a plurality of pipe joints which are connected together as the riser is lowered from the vessel.

9. A method as claimed in Claim 8, comprising lowering a first length of flexible pipe, connecting a first rigid pipe joint to an upper end of said flexible pipe, lowering said rigid pipe joint, connecting additional rigid pipe joints to the upper end of the preceding pipe joint and lowering said additional pipe joints, as required, connecting a second length of flexible pipe to the upper end of the last rigid pipe joint and lowering said second length of flexible pipe.

10. A method as claimed in any one of Claims 8 to 9, wherein the vessel is a dynamically positioned vessel and the pipe is lowered from a derrick located on the vessel, via a moon-pool.

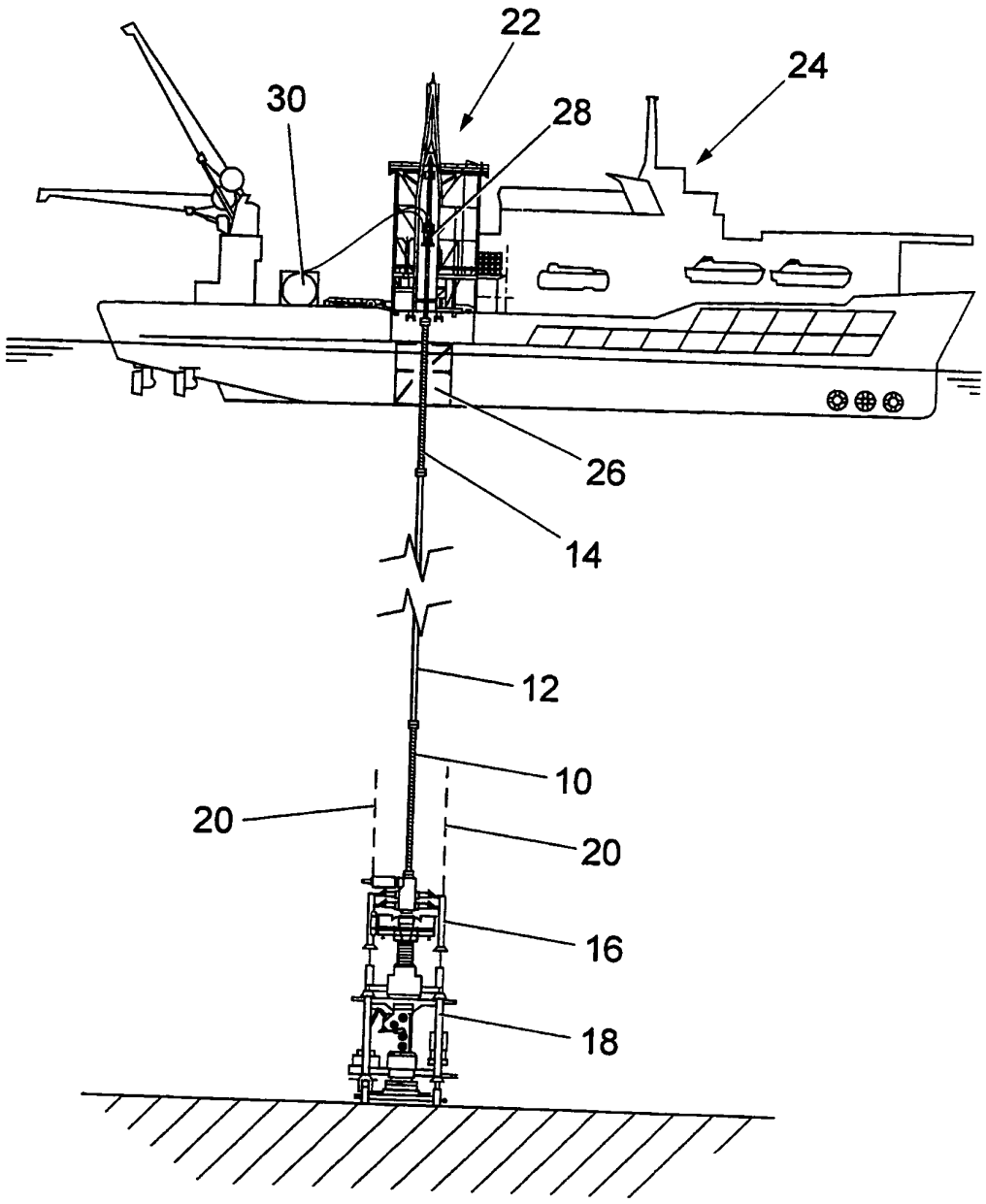

Fig. 1

INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E21B17/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 4 741 647 A (DUMAZY CHRISTIAN ET AL) 3 May 1988 see abstract	4
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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